4.0 Emerging Approaches

This approach to time-of-day assignment is, in fact, research. This approach has not been implemented yet at either the MPO or state DOT levels. The peak spreading approaches described in the previous section do not fully address travel response to system changes and, thus, cannot be used to fully analyze policy changes or effects of travel demand management actions. The intent of this approach is to model traveler response to congestion in much the same way that mode choice is modeled. While there are no working models at present, there is potential for implementation of this procedure within the traditional four-step modeling process.

Despite the improvements in estimating time-of-day travel behavior presented previously in this section, there is a fundamental issue that remains unresolved: given that a traveler is making a trip, how does he/she decide what time to make the trip? This decision is affected by several factors, many of them unrelated to the trip or travel conditions. These include:

- Required arrival times (such as for work and school);
- Times the destination is "open" (such as for stores, offices, etc.); and
- Personal or household factors such as preferred mealtimes, other family activities, etc.

Travel condition or trip-related factors affecting time-of-day choice include:

- Level of congestion;
- Availability and level of service of transit modes;
- Auto availability; and
- Pricing differentials (parking, tolls, fares, congestion pricing).

There are at least two levels of this time-of-day choice question that need to be addressed:

1. In which period (a.m. peak, midday, p.m. peak, etc.) does the trip take place?
2. Given the period in which the trip takes place, what is the actual departure time?

The former is an important question in the analysis of such policies as congestion pricing. It is also the issue for which information is easier to obtain; transit schedules and fares, estimates of highway congestion, and other information are likely to be available by time period. In theory, it would be possible to develop a time period choice model using this information.

The second question refers to the type of information that might be used in the implementation of dynamic assignment or traffic simulation procedures. While in theory this should be conducted at a relatively continuous level, practicality dictates that "time slices" of five to fifteen minutes are the shortest intervals that could be modeled. This is due to the constraints of data. For example, survey respondents often report times to the nearest five or fifteen minutes, and traffic counts necessary for validation would not be available for shorter intervals. Perhaps a larger problem, however, is that data on which the choice would depend, such as transit level of service and congestion, would not vary enough to provide a basis for choosing a particular departure time. In addition, the types of departure time decisions reflected in route choice analysis do not seem to correspond to mode and destination choice and the decision whether to make a trip at all.

What is lacking in the innovative peak spreading approaches is a choice-based analytical approach. Through various travel surveys, we know that increasing congestion leads to the spreading of the peak period. The following traveler responses to congestion might be expected:

- **Seek Alternative Travel Route.** If excess highway capacity exists, travelers will seek alternative routes, even indirect ones, to reduce travel time. This process is currently being modeled through the equilibrium trip assignment process in microcomputer-based travel demand modeling systems. However, the limits of route diversion are not well defined. The amount of extra distance that travelers will travel might be limited. Cost-based trip assignment procedures offer some potential for solving this problem.

- **Shift Modes of Travel.** In cases where there are exclusive bus lanes, HOV lanes, or other transit options, a shift from single occupant vehicles to transit or rideshare modes is reasonable. Many mode choice models currently provide this analysis capability.

- **Change Destination.** In the case of trips where multiple alternative destinations could satisfy the trip purpose (i.e., shopping), the traveler may choose an alternative destination, even if it is less convenient from a travel distance perspective. The effect of this choice is currently modeled to some degree, especially if feedback loops are employed.

- **Stop Making the Trip.** If the trip is non-essential to the household, the trip maker can choose to not make the trip at all or satisfy the trip purpose through other means such as telecommuting, teleshopping, or chaining the trip with other, necessary travel. Typically, these choice mechanisms are not currently modeled within the traditional four-step modeling process. However, these types of strategies are approximated as part of post-travel demand modeling analysis.

- **Make the Trip at a Different Time-of-Day.** The traveler can choose to avoid peak period congestion by moving the start or end time of the activity so that the travel time does not coincide with peak period congestion on the highway network. This obvious response to increasing congestion is not currently modeled. Nevertheless, the potential exists to develop choice models along the lines of mode choice models to address this traveler option.

One commonly noted difficulty in implementing this approach is that the above choices are not independent. In reality, the decision about the time a trip is made is interlinked with the destination, mode, and route choice decisions. One purpose of TRANSIMS and other research related to activity-based modeling is to more accurately model the options and choice mechanisms of travel. Nevertheless, in the short-term, adding time-of-day choice modeling to the four-step modeling process appears to be a reasonable approach within the resources of many agencies responsible for travel demand modeling.

There are problems associated with modeling the time-of-day choice separately from other travel decisions. The problem with modeling time-of-day choice early in the four-step process is that subsequently modeled decisions have no effect on time-of-day choice. For example, modeling time-of-day choice prior to mode choice fails to consider that transit trips are more likely to occur during peak periods due to increased availability of service. Another issue is that separate models for each time period must be developed for later steps in the modeling process. On the other hand, modeling time-of-day choice later in the process assumes that time-of-day has no effect on previously modeled choices. For example, modeling time-of-day choice after mode choice fails to consider that the time the trip is taken has an effect on the mode chosen and, perhaps, the destination.

Peaking and time of travel are critical determinants of level of service, traffic congestion, and concentrations of emissions. For example, the success of strategies to reduce the intensity of highway congestion depends critically on a low elasticity of trip departure time with respect to trip duration, yet common experience on congested facilities suggests otherwise, i.e., peaks narrow but do not decline in intensity very much. Recognizing this, researchers interested in congestion relief and highway pricing have been working on a more realistic behavioral representation of peaking.

Using the example of the a.m. peak period work trip, peak spreading results from two related phenomena:

1. The adjustment of departure times in response to a perception of increased (or less predictable) door-to-door travel times. There is no effect on the timing of activities (work).

2. The rescheduling of activities to allow for a more satisfactory (or affordable) travel experience. Both trip departure and activity start times may vary.

The first phenomenon is simpler to address analytically. It implies a straightforward relationship between decreasing speeds and a broadening peak. However, this relationship may still require a resourceful extrapolation to estimate future values on the basis of current and available travel survey and count data. This analytical approach would require better-than-average estimates of travel time in the peak and off-peak period.

The second phenomenon has been the focus of much research over the past decade. This research falls roughly into four categories:

- Empirical studies of highly-congested corridors;
- Thought experiments with bottleneck queuing models;
- Econometric analyses of stated time-of-travel preference; and
- Econometric analyses of revealed time-of-travel preference.

References on this research are listed at the end of this section. The revealed preference studies, in particular, have been quite promising. They indicate substantial activity scheduling (hence, travel time) elasticities with respect to travel conditions, and suggest a close relationship among activity timing, trip generation, trip distribution (destination choice) and trip chaining.

While time of travel choice models are probably not ready to move into the mainstream of regional travel demand modeling, research has come far enough and the models are sufficiently well-behaved that their introduction into advanced modeling practice would be desirable. Several MPOs, including MTC (San Francisco Bay Area), Metro (Portland, Oregon), and SACOG (Sacramento) have proposed explicit time choice components for proposed travel demand model system updates. These proposals include the following:

- A model of time-of-day choice that predicts the period of travel as a function of variables such as free flow and congested travel times, transit level of service, trip purpose, and area type variables. This can be a logit model that could be applied after mode choice.
- A model of whether peak period trips occur in the peak hour or not. This can also be implemented as a logit model as part of a "variable demand" multiple vehicle class assignment. Use of a variable demand assignment guarantees that the results of the peak hour models are in accord with the congestion resulting from the assignment. Off peak vehicle trips would still be assigned using a traditional static demand assignment.
- A model based on a combination of traditional TOD factors and a binary time-of-day choice model. The choice model will be based on congestion represented by peak/off-peak travel times, delays, etc. The underlying hypothesis is that relatively higher congestion during peak time results in a higher likelihood of off-peak choice.